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ABSTRACT

Four methods of individualized instruction are described and introduced, and their similarities and differences are reviewed in terms of effectiveness, grading, lectures, mastery, pacing, theoretical base, and unit size. The methods described are (1) audio-tutorial, developed by S. N. Postlethwait, an instructional system that allows students to use a study carrel and proceed at their own pace using a variety of educational devices; (2) guided design, developed by Charles E. Wales and Robert Stager to teach problem-solving skills in undergraduate engineering courses, an approach that relates objectives to specific activities through single-answer and open-ended problems; (3) a personalized system of instruction, developed by Fred S. Keller, J. G. Sherman, Rodolfo Azzi, and Carolina Martuscelli Bori to teach psychology, a method that used a teaching system based on operant psychology; and (4) individualized lecture classes, initially originated at Western Michigan University by Jack Michael, which typically include study objectives, unit assignments, frequent quizzing, scheduled lectures and quizzes, and some remediation procedures. A comparative matrix, 13 reference notes, and an 8-page reference list are included. (LMM)

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Individualized Instruction: A Review of Audio-Tutorial Instruction, Guided Design, the Personalized System of Instruction, and Individualized Lecture Classes

by

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This paper was written in partial fulfillment of the doctor of philosophy degree for the Department of Human Development and Family Life, University of Kansas, under the direction of Dr. George Semb.

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Individualized Instruction: A review of Audio-Tutorial Instruction, Guided Design, the Personalized System of Instruction, and Individualized Lecture Classes

> The most fundamental truth about human behavior plainly requires the abandonment of instructional techniques and conventions of judgment which assume that all children are essentially alike.
>
> Bushell, 1973, p.9

> ...what any person in the world can learn, almost all persons can learn if provided with appropriate prior and current conditions of learning.
>
> Bloom, 1976, p. 7

A-T, CBI, DI, IMS, ML, PA, PDI, PL, PSI, TML; what do the letters in this alphabet soup have in common? They are all initials for different methods of instruction. Although this list is not exhaustive, it is representative of myriad attempts to improve, augment, and redesign conventional instruction.

In this vein, Sidney Pressey developed the "teaching machine" (Pressey, 1932), which used the principles set forth in "programmed instruction" - another concept for which Pressey was responsible (Lefrancois, 1982). However, it was famed Harvard psychologist B. F. Skinner

who popularized the teaching machine (Skinner, 1954), and was subsequently made the victim of the following limerick:

Word has come down from the Dean
That by use of the teaching machine
Old Oedipus Rex
Could have learned about sex
Without ever disturbing the Queen!
(Note 1)

Skinner's linear programming is probably the best known application of behavioral psychology to the field of education (Lefrancois, 1982). But he is certainly not the only Harvard-trained psychologist to apply the principles of learning theory to educational technology. In the late sixties Fred S. Keller, life-long friend of Skinner and one of the most influential people in Skinner's life (Skinner, 1979), published a description of an innovative teaching methodology (Keller, 1968). Both the Keller Plan, or Personalized System of Instruction (PSI) as it is often called, and programmed instruction have a strong commitment to mastery. In fact, one exponent of Mastery Learning, Benjamin Bloom, has written, "By far the most widely used mastery learning approach is the Keller system of instruction." (Bloom, 1976, p. 199).

Another important feature these two teaching methodologies share is individualization. But these are not the only individualized instructional technologies. Other systems, from disciplines such as biology and engineering, focus on the individual learner. This common thread, an emphasis on individualized instruction, brought together the members of the International Society for Individualized Instruction (Chapman,

1983).

The Society represents five methods of individualized instruction. They are:

1) Audio-Tutorial (AT)
2) Computer-Based Instruction (CBI)
3) Contingency Managed Lecture (CML)
4) Guided Design (GD)
5) Personalized System of Instruction (PSI)

This paper briefly introduces AT, GD, PSI, and methods used to individualize lecture classes, and then reviews their similarities and differences in: effectiveness, grading, lectures, mastery, pacing, theoretical base, and unit size. Computer-based instruction has been omitted from this review as, at present, it refers to a variety of different instructional delivery methods rather than an integrated instructional system.

AUDIO-TJTORIAL (A-T)

> Now it is necessary to refocus on the basic problems and resist the strong temptation to use the new communication tools as we have "always done in the past".
>
> (Postlethwait, Novak, & Murry, 1972, p. T)

Developed by Dr. S. N. Postlethwait as a method to teach introductory botany at Purdue University, A-T started as the simple use of tape recorders for supplementary lectures. It soon became an instructional system that allows students to arrive at a study carrel and proceed at their own pace using a variety of educational devices to contact the insructional material. The premise of the A-T system is, "...learning is an activity done by an individual and not something done to an individual" (Postlethwait, Novak, & Murry, 1972, p. 1).

The A-T methodology practices an individualized approach by providing students with a taped presentation of a specially designed program that directs their activities one at a time. This format is convenient for both the students and the instructor. For example, the instructor is free to interact with each student individually, becoming a personal tutor. Students are free to use the materials at their own pace in the study booth.

The following is a description of an A-T style class from the students viewpoint. First, students attend the independent study session

where they check into a booth, sit down and read the day's set of instructional objectives. With their books in front of them, the students begin listening to the recording. The instructor's voice explains what material is to be covered during this portion of the lesson and prompts the students to study the material by friendly conversation that leads to the topic at hand. When the instructor begins talking about the material, students are directed to the study guide, perhaps stopping the tape momentarily to reread the material. The instructor occasionally pauses to allow students to complete an experiment or exercise. Students unclear on what to do might go back and listen to the instructions again. Those who understand the exercise complete it and proceed.

After progressing through their study guide, students might then be directed to a reprint from a scientific journal or perhaps look over a larger display on a central table. Returning to the booth, students might be presented with a review of the material covered up to this point. Material not well understood can be restudied at this time. Continuing, the lesson provides students with more exercises. Hence, students are constantly interacting with the materials, stopping only to ask for help, take a break, or review material.

The study guide, written in a workbook format, provides students the opportunity for structured responding. The forms printed in the guide make it easier for students to follow along with the tape as they work through the exercises. The study session might end with a viewing of a short film illustrating the main point of the day's lesson.

After a visit to the study area, students might have an assigned general assembly session. These sessions require attendance since they

are held to present material that cannot be presented in the study booth.

After the week's lesson has been covered in both the independent study session and the general assembly session, it is time for the integrated quiz session. Here about eight students gather to be quizzed orally. Answers are discussed by the group to arrive at each student's oral quiz grade. After all students have had their oral quiz, they take a small written quiz. Questions from both quiz formats might appear on the final examination.

The book The Audio-Tutorial Approach to Learning, by Postlethwait et al. (1972) makes clear that A-T is not merely the presentation of a recorded lecture. Rather, it is a series of programmed learning activities integrating information presented in lectures, assigned readings, experiments, movies, and guest lectures. (This list is by no means exhaustive.) The A-T approach encourages the use of a variety of instructional modes attempting to match the best method of information transmission with the appropriate objective.

Postlethwait et al. (1972 pp. 3-6) present seven guidelines for an effective educational program and provide examples of how the A-T approach satisfies them. They are: repetition, concentration, association, unit steps, use of the communication vehicle appropriate to the objective, use of a multiplicity of aproaches, and use of an integrated experience approach.

1. Repetition: A-T allows students to adjust the amount of repetition necessary to understand the material. This self-pacing feature is particularly nice since a longstanding complaint of linear

programming is that some students become bored from excessive repetition.

2. Concentration: Because attendance does not necessarily ensure attention, A-T allows students to interact with the instructional materials when they are ready.

3. Association: The objectives taught are presented in many different ways providing students with several examples to relate together; related material being easier to learn than dissociated material.

4. Unit steps: This self pacing feature allows students to select the unit size best suited for them; an issue of concern (e.g., Semb, 1974).

5. Use of the communication vehicle appropriate to the objective: Respecting the fact that students learn when they are involved or engaged in a procedure, the A-T approach provides a variety of opportunities for students to use the information being presented in the instructional objective (e.g., a film on plant growth utilizing high speed photography to illustrate a concept that would be much more difficult to describe in writing).

6. Use of a multiplicity of approaches: Students are offered the instructional medium of their choice because so many different alternatives are available to teach the same point.

7. Use of a integrated experience: A-T provides a logical sequence of programmed instructional activities, that build one upon another, allowing students "greater achievement and understanding than if these events are randomly sequenced and disassociated" (Postlethwait, 1972, p. 5).

Postlethwait et al. (1972) also list 13 features of the A-T procedure that illustrate the benefits of the system. In their words:

1. Emphasis is placed on student learning rather than on teaching.

2. Students can adapt the study pace to their ability to assimilate the information. Exposure to difficult subjects is repeated as often as necessary for any particular student.

3. Better students are not a "captive audience" and can use their time most effectively. Their interests are not dulled by unnecessary repetition of information already learned but they are free to choose those activities which are more challenging and instructive.

4. Students can select a listening time adapted to their diurnal efficiency peak.

5. Tapes demand the attention of the students. Students are not distracted by each other.

6. Students can have more individual attention, if they desire it.

7. Scheduling problems are simplified. The hours of scheduled time from which the students are relieved under the new system can now be distributed throughout the week as necessary to adjust to their activities.

8. More students can be accommodated in less laboratory space and with less staff.

9. Make-up labs and review sessions can be accommodated with a minimum of effort.

10. Students feel more keenly, their responsiblity for learning.

11. Each student is essentially "tutored" by a senior staff member.

12. Potentially, the system can be used to standardize instruction where desirable, e.g., between the University and the University Centers.

13. Opportunities for research on learning processes are enhanced. (p. 131)

In an attempt to place a greater emphasis on the role of the learner, as opposed to the teacher, various aspects of the instructional system have been reorganized. New names and purposes for traditional aspects of group instruction found in the A-T method include:

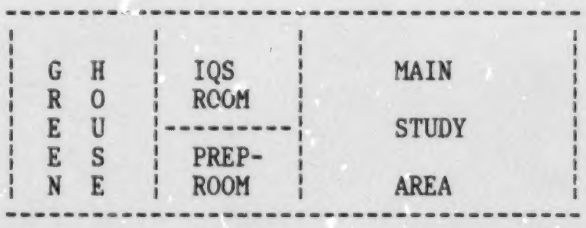
1. The independent study session which occurs in the learning center. Here students sit in study booths to contact the instructional material.

2. General assembly session where students attend activities involving larger numbers of students such as guest lecturers, long movies, or the administration of large exams.

3. Small assembly sessions are made up of two types of activities; a) an integrated quiz session where students are given a weekly quiz, part oral and part written, and b) other small assembly sessions where anything the instructor feels needs to be presented in a small group format may be dealt with.

The physical facilities for an A-T style course require some modification of a typical classroom arrangement. But these changes are

relatively simple and, especially if other classes in a department use the A-T system, an efficient use of space. The introductory-botany course at Purdue University uses a set-up something like this:



At Purdue University, the booths are designed specifically for the A-T format. They use cassette tape recorders along with Super 8 movie projectors built into pegboard dividers. Thus, students have privacy, work space, and an array of materials mounted on the pegboard in front of them. Other tables located in the room display film loops, exhibits, and other instructional aids the instructor feels is important.

GUIDED DESIGN (GD)

> ...teaching is not just an art based on the science of psychology, but a form.
>
> (Wales & Stager, 1977, p. iii)

Developed as a method to teach problem-solving skills in undergraduate engineering courses at West Virginia University, Dr. Charles E. Wales and Dr. Robert Stager have created a unique procedure that is designed to teach students how to apply the subject matter being taught. This is done in a systematic format using simulated or real problems that the students must solve under the direction (guidance) of the instructor. According to the developers, Guided Design is a "slow motion exposure in decision making" where "learning is not left to chance" (Note 2).

Learning is guided by instructional objectives describing the subject matter involved in students' work. Instructional objectives are "intentions communicated by a statement describing a proposed change in the learners - a statement of what the learners are to be like when they have successfully completed a learning experience" (Mager, 1962). For example, an instructional objective might state, "After reading chapter 2 the student will be able to identify and recall all 50 of the United States." The goal of Guided Design is to relate objecttives to specific activities through single-answer and open-ended problems (Wales, 1976).

Students are guided by the organization of concepts and principles in a sequence from simple to complex . At the same time, they are

provided with verbal and visual tests, mneumonics, tables, and graphs to enhance learning. Demonstrations, or situations in which students experiment with the desired behavior, can also be included. The instructor supervises the initial trials, and gradually withdraws prompts as students are also being taught how to evaluate their on performance (Wales, 1976).

What motivated two engineers to develop this teaching methodology? Wales and Stager (1972 p. 456) counter with their own question, "Why have engineers demonstrated a greater concern for the education of their students than other professions?" They go on to say, "...the best explanation seems to lie in the engineer's natural bent to solve problems...". Indeed, while Wales and Stager's engineering background bears on Guided Design, the system also draws from a variety of disciplines for its theoretical base. The engineering systems design approach used to develop a guided design course allows incorporation and integration of the best educational and psychological principles into a uniform system (Feldhusen, 1972). Guided design draws from modeling concepts, cognitive psychology, and learning theory. This eclecticism is looked upon favorably, and is even referred to as the "richness in the system" (Feldhusen, 1972). It is best reflected in the following quote from Feldhusen (1972, p. 542): "While the theoretical underpinnings of this guided design course are drawn eclectically, it is nevertheless an integrated, consistent whole".

Guided design is an active process. Students gather in small groups and appoint group members to lead various steps of the project. The instructor presents the group with a problem written in advance.

Students are allowed to take as long as necessary, given the constraints of the class period, to make various decisions regarding the problem, and then select a final solution. The final solution, however, is not as important as the process by which decisions are made. Teaching students how to make decisions is, as Wales and Stager (1977) point out, analogous to the proverb, "If a person is hungry, you can provide a fish or a fishing pole". Hence, guided design is a procedure to teach students how to solve problems. In fact, according to the developers, guided design has combined two educational goals that have previously resisted integration: (a) teaching the subject matter, and (b) developing solutions for real world problems (Wales & Stager, 1977, p.iii). The emphasis is on doing rather than listening.

An example of a guided design lesson, provided in the book Guided Design (Wales & Stager, 1977), outlines the basic components of the system. First, the instructor introduces the program and decision-making process to the students. Second, the instructor describes the day's assignment and problem to be solved. Third, details are presented relating to the setting being used to illustrate the problem.

The First Exercise - Individual work is presented after the Setting has been described. Typically written by the instructor, this exercise involves students in the initial stage of analyzing the scenario by asking: "What is the problem that needs to be solved here?" Next, small groups (5-6 people) are formed to start the decision-making steps in an "instruction-feedback" pattern. In the instruction-feedback pattern, written materials present students with questions that sequentially move up the decision-making hierarchy. Possible answers to the last exercise

suggested by the instructor are provided with the new instructions. Hence, the term instruction-feedback. While no one particular answer is identified as correct, a list of possible answers are offered to the students alowing them to see what other decisions they might have arrived at and why.

Students are required to work, cooperatively, towards a solution resulting in a group response for the following components of the scenario and the decision-making steps they involve:

COMPONENTS	DECISION-MAKING STEPS
Instruction A - The problem: The group attempts to generate a list of possible problems that they should try to solve.	* Gather Information Listed seperately, this step occurs throughout the entire procedure as the students search for pertinent information.
Instruction B - Identify the problem: The group analyzes the list of problems to identify the one for which a solution would most benefit the group.	A) Identify the Problem: Analyze the symptoms to determine the exact problem - according to the group. B) State the Basic Objectives or Goal: The basic objective is formulated to state the real problem and check the decision-making conducted thus far.

Instruction C - Facts, Assumptions, Constraints/ Choose a Solution: These variables are listed and analyzed to develop possible solutions.

(Feedback provided for A.)

C) Component analysis: Identify the major components of the "setting". (Feedback provided for B.)

D) State the constraints, Assumptions and Facts: Consider factors limiting the outcome of the group's decision and assumptions that simplify and make the problem more solvable. (Feedback provided for C.)

E) Generate Possible Solutions: Brainstorm all the ideas the group can generate without pre-judging them. (Feedback provided for D.)

F) Choose the Best solution: After devising criteria to judge the possible solutions, consider the positive and negative consequences of each choice. Then determine a possible solution that is most likely to solve the problem. (Feedback provided for E.)

Instruction D - Analysis/ Synthesis: The group reviews the ideas generated and synthesizes them into a final plan.

G) Analysis: Identify the key variables that need to be considered for implementation of the solution. (Feedback provided for F.)

H) Synthesis: Create a detailed solution after considering the variables generated during the analysis. (Feedback provided for G.)

Instruction E - Evaluation: Students compare their individual and group proposals with that from an objective expert (provided in the scenario by the instructor.)

I) Evaluate the Solution: Assess the negative consequences of the solution. Consider feasibility, economy, safety, legality, etc., and whether or not it satisfies the basic objective or goal. (Feedback provided for H.)

J) Make Recommendations: Decide whether to pursue further ideas or to implement the chosen solution. (Feedback provided for I.)

K) Report the Results: Describe what has been done

considering the needs of the report's consumers. (Feedback provided for J.)

L) Implement the Decision: Take action.

M) Check the Results: Decide whether or not to go back to step I.

An example of the guided design method of problem solving using a hypothetical problem of deer crossing a busy highway taken from Wales and Nardi (1983, pp. 12-13) follows. The number of options considered in each step is abbreviated in the interest of brevity. If this problem was really being solved in a GD class the number of possible solutions would be greater.

The Deer Problem

Situation;

Several employees have been injured on their way to or from work in deer accidents.

Gather information; (Occurs throughout the exercise.)

What is the extent of the problem?

Goal; (Decision making step B.)

The goal is to reduce the number of people hurt or killed.

Component Analysis; (Decision making step C.)

People, cars, deer, and the road.

Constraints; (Decision making step D.)

Busy highway, large forest, many deer, hunter groups, humane society, limited funds.

Possible solutions; (Decision making step E.)

People: education, warning signs, defensive-driving. Cars: new design, bumper, brakes. Deer: shoot, relocate, frighten. Road: fence, bridge, close, lower speed limit.

Gather more information;

Who is involved? Drivers of all ages.

Who is not? No one group of people.

What is involved? Car hits deer in road or swerves and hits another car or tree.

What is not involved? No pattern of driver error. No similar makes or models of cars. Not poor repair.

When does it occur? Usually, but not always, toward dusk at night, or near dawn.

When does it not necessarily occur? In bad weather: snow or rain.

Where? Usually near specific wooded areas.

Where not? Open country or necessarily where woods are close.

How often? In one state there were 23,000 deer-car accidents in one year.

Choose; (decision making step F.)

It would be very difficult to change all cars. People refuse to wear seatbelts. Elimination of salt and short grass that draw deer to the road is too expensive, hence, the first choice is new or better signs.

Analysis; (Decision making step G.)

Sign; How large? What shape? What message? What colors? Lighted? What type of support? Who would make them? Install them? What is the cost per installed sign?

Location and number; How far from pavement? How far between signs? Which stretches of highway?

Pilot program; Should this be tested on a small scale? What kind of reduction is expected? What data should be collected? What legal problems exist? Who is going to pay for it?

Synthesis; (Decision making step H.)

A detailed plan is developed for flashing lights.

Evaluation; (Decision making step I.)

Flashing light signs might be devised to reach a possible goal of reducing the number of injuries and deaths by 20% and stay within the cost constraint. The decision will be tested by the continued number of deer accidents.

Decision steps J,K,L, and M would be performed after implementation of the solution arrived at in step F).

Students are also assigned readings and are frequently quizzed over study guide material to ensure that they will keep up with the group effort to solve the exercise. While the students participate in the collective effort in class, they are also given an individual exercise to solve which constitutes the greatest portion of their grades. Students are evaluated on how well they followed the decision-making hierarchy, how they justified their decisions, and the quality of the written report.

The instructor serves as a mediator for the small groups, prompting students to suggest various proposals and arrive at particular conslusions. The students learn through actually performing the exercise and experiencing the consequences of their suggestions and conclusions. Successful ideas are tried again, and unsuccessful ones abandoned.

PERSONALIZED SYSTEM OF INSTRUCTION (PSI)

> PSI offers success in a context where (unsuccessful) students have never known anything but failure...
>
> Golden & Boylan, 1978

Developed in the middle sixties as a method to teach psychology at the University of Brasilia (Keller, 1982), Fred S. Keller, J. G. Sherman, Rodolfo Azzi, and Carolina Martuscelli Bori designed a teaching system based on operant psychology (Keller & Sherman, 1982). PSI has received a great deal of attention in the literature (e.g., Kulik, Jaska & Kulik, 1978) with researchers manipulating different variables trying to determine exactly what combination of procedures result in the most effective teaching system. The philosophy behind PSI, however, is simple: effective teaching, according to Keller, "is a matter, not of 'show and tell,' but the arrangement of conditions for happy and effective learning" (Keller, 1982 p. 78).

The book Pedagogue's Progress (Keller, 1982 p. 32) details six rules that provide rationales for the PSI system. To paraphrase, they are:

1) Nothing of practical importance is ever learned by virtue of simple repetition.

2) We learn through doing.

3) Immediate consequences are the most effective.

4) Learning through reward is easier and more precise than escape from pain or the avoidance thereof.

5) Punishment of "wrong" behavior may weaken it for some time, but it may also lead to the avoidance of those circumstances in which the punishment has been applied.

6) Complex repertoires of responding are established through a gradual progression.

PSI, as Keller (1968) originally described it, has five features. They are:

1) Mastery learning; A demand for perfection.

2) Self-pacing; The go-at-your-own-pace feature.

3) Stress on the written word; the instructional materials must be presented in a sequence of small units leading from the simple to the more complex, with objectives clearly specified.

4) Student proctors; who allow the instructor more time to help those students who required the instructor's level of expertise.

5) Lectures for motivation rather than information; Since they are no longer required, lectures may be used as reinforcers.

Keller (1982) offers adopters a prescription for setting up a PSI course. Nine instructions are provided. Briefly they are:

1) Break down your course into small assignments (units).

2) Let students go at their own pace through these units.

3) Tell the students what is expected of them on each unit.

4) Make use of student proctors.

5) Don't demand attendance at lectures and don't examine students on what you say or do.

6) Keep yourself within the classroom.

7) Modify your course materials immediately in accordance with the feedback from your pupils and proctors.

8) Give all your pupils A's when they satisfy your requirements.

9) Don't start this endeavor unless you have the backing of your department.

Keller (1982) concludes by stating,

> All this may lead the reader to conclude that personalized instruction is a panacea for the major ills of education in our times. I should like to think that this is true, and I believe it could be, but the obstacles to such a cure are many. (p. 69)

Students in a PSI class find themselves with much more autonomy than one might expect from such a highly structured teaching system. When to study, how much to study, when to go to class, and how soon to finish the class are just a few decisions PSI students make for themselves. For example, at the start of the semester, students meet their proctors and become acquainted with the course policies. If this is presented in a lecture format, it could be the last required lecture they will attend. Few students are pleased with the number of quizzes

they are told they will be taking. Once the students have met with their proctors they begin. Small units in their book have been assigned - small in size, but large in number. Some students will begin immediately, seizing the opportunity to work ahead of their other classes. Others will not put their PSI class at the top of their semester's objectives list.

When students return to class, they meet with their proctors to receive a short quiz over the reading assignment. The quiz may be multiple choice or short answer, or both, and typically takes ten to fifteen minutes to complete. After completing the quiz, students return to their proctors to have it graded. While they might wait in line a short time, once their proctor is free their quizzes will be graded immediately, and students can discuss answers that do not match the answer key. And, after having tried to explain their answers, they are either told to return to the quiz area to correct their mistakes or advised to retake the quiz after more preparation if they have not met the mastery criterion.

Some PSI courses have larger cumulative "review" exams after every few units and require students to pass a comprehensive final before receiving a grade in the class.

The instructor ends the semester having assigned all the students who demonstrated overall mastery of the material "A's" - a policy which will receive much attention from the school's administration, the instructor's colleagues, and, to the benefit of the next semester's enrollment, students who have yet to take the course.

INDIVIDUALIZED LECTURE CLASSES

> ...in retrospect I wonder (half in jest) how much of our de-emphasis of the lecture was dictated by the fact that ten years ago neiter Keller or myself could speak more than a few words in the language of the country [Brazil] we were called upon to teach.
>
> (Sherman, 1982, p. 13)

Individualized lecture classes originated at Western Michigan University in the late sixties. The original model for this approach was developed by Dr. Jack Michael and the first publication of this instructional method appears in the Psychological Record in the early seventies (Cooper & Greiner, 1971).

Individualized lecture classes typically include the following instructional components (Semb, Glick, Spencer, 1980):

1) Study objectives
2) Unit assignments
3) Frequent quizzing
4) Scheduled lectures
5) Scheduled quizzes
6) Some remediation procedures

As Drake, Phillips and Semb (Note 3) have written;

> The basic difference between PSI and individualized lectures is that the instructor rather than the student, sets the pace of the course. Students who might benefit from the self-pacing and or the opportunity to retake quizzes until mastery is achieved are not afforded those opportunities. However, in most individualized lecture courses, students are allowed to remediate each assignment at least once. (p. 1)

Although there is no one particular format for individualized lecture classes, lectures and written materials are typically divided into small units accompanied by a study guide or a set of written instructional objectives (cf., Schreiver & Carlson, 1978). At the first class meeting each week, the instructor usually lectures to the students and then administers a quiz.

If remediation is required, as determined by unsatisfactory performance on the initial quiz, a remediation lecture is given on the next class day. Students needing remediation might be required to attend the remediation lecture or it may be optional with an incentive for attendance (cf., Bostow & Blumenfeld, 1972; Bostow & O'Conner, 1973; Phillips & Semb, 1976). Frequently there is a third meeting when students can attempt improve their grades.

Remediation of unsatisfactory performance can take many forms. Barton, Freeborn, and West (Note 4) have developed and tested a procedure whereby students failing to pass the initial unit quiz are allowed to earn one half of a bonus point for turning in a completed remedial study guide. Another half of a bonus point is awarded for handing in a corrected answer to a mini-quiz over a remedial discussion. This

discussion, however, is not merely a rehashing of the material previously assigned. Rather, it is a discussion, by the group, of problems experienced with the readings and quiz. The instructor serves as a group moderator or discussion leader rather than lecturer. Hence, students are provided an incentive to attend the remediational session where, according to the authors, they better prepare themselves for a retake of the unit quiz.

In another interesting manipulation of remediation technology Drake, et al., (Note 3) awarded students earning 15 or less points (out of 20) zero points. Their lost points could be earned back however, by attending a prevention session where the instructor quizzed them on the next lesson. Students correctly answering questions over the next lesson also received half of the points they needed to earn a perfect score. Hence, a student earning a 10 on an initial quiz would receive a zero, but could earn back the 10 points by attending the prevention session where they could earn half the points they were deficit from a perfect score (20 - 10 = 10 divided by 2 = 5) for a total of 15 points. Thus, the emphasis is on requiring students to prepare for the next lesson, and therefore not require remediation again. The experiment revealed that a majority of the students requiring remediation were indeed helped by this procedure.

The activities that occur during the remediation period as well as the schedule of quizzes and lectures are idiosyncratic to each instructor, but the following diagram taken from Bostow and Blumenfeld (1972) is representative of a typical weekly activity schedule:

Monday	Wednesday	Friday
Initial quiz	Return quizzes & lecture-discussion	Remedial quiz

CENTRAL ISSUES

A better understanding of the instructional methodologies reviewed in this paper can be gained by analyzing educational features they have in common. In this section, the issues of effectiveness, grading, use of lectures, mastery, pacing, theoretical base, and unit size are addressed. A comparative matrix is provided at the end of the section summarizing the similarities and differences between A-T, GD, PSI, and individualized lecture classes.

> While nothing in instructional technology can be shown to work in all cases for all populations and for all instructors, an interesting trend seems to have developed.
>
> (Ruskin, 1983)

Effectiveness

Though some more than others, all four of the instructional systems reviewed in this paper have been evaluated; A-T, GD, and PSI with traditional instruction, and PSI and individualized lecture classes with each other. In all, hundreds and hundreds of studies have been conducted. And while not all these investigations have been rigorous enough, nor asked important enough questions, conclusions regarding their effectiveness relative to group systems of instruction are

possible.

Audio-Tutorial

A-T has been evaluated in almost 100 investigations (Fisher, 1976; Mintzes, 1975). Unfortunately, most of these studies lack sufficient experimental control or fail to ask significant questions (c.f. Mintzes, 1975). Mintzes (1975) described this dilemma as follows:

> Although a good amount of research has been done in the field of A-T instruction, I believe it is fair to say that many of the results have thus far been disappointing. This may be due in part to a lack of methodological sophistication on the part of the researchers, as well as their failure to tackle questions of sufficient importance. (p. 251)

> In summary, the results of comparative studies appear to be inconclusive and even contradictory. Of the seven studies reported here, three found the A-T approach to be significantly better, two found no differences, one found the conventional method better, and one failed to use a control group. (p. 248)

Similarly, Fisher (1979) had this to say:

> ...there is a relative paucity of research in published, refereed journals; it seems that more than half of the work in the field appears in unpublished theses and other reports. (p. 695)

After selecting only the more rigorous of the many studies conducted on A-T, the conclusion regarding A-T's effectiveness compared to conventional instruction favors A-T by two to one (Fisher, 1979;

Mintzes, 1976). However, more research of higher quality and significant inquiry needs to be conducted to arrive at a firm conclusion regarding its effectiveness. Two firm conclusions that can be made regarding A-T are: (a) students rate it favorably, and (b) withdrawal rates tend to be much lower in A-T than traditional lecture classes (Gould, Langford, Mott, 1972; Hahn, 1971; Hinton, 1970; Williams & Rich, 1968).

Guided Design

Because GD is a set of procedures that can be taught via PSI, A-T, or other formats (Wales & Stager, 1977, p. 30-31), comparing traditional lecture classes with GD would warrant evaluations of GD presented in various modes. The literature to date, reveals two studies that compare GD with traditional lecture classes in post-secondary education.

In one of these investigations (Miller, 1981), students rated GD as resulting in more desirable educational outcomes (e.g., realizing potential, taking responsibility, or improving communication), and conventional lecture as satisfying more important outcomes (e.g., accumulated knowledge, graduate school admission, and better grades). There were 30 items to be ranked ranging from, "A person would learn to lead others" (rated by most -- 96% -- of the students as being a result of GD) to "Academic grades would be high" (rated by the fewest -- 14% -- students as being a result of GD). This investigation also reports a strong correlation between students' reported cohesiveness in the small groups and high course ratings for GD.

Another report describing GD in comparison to traditional instruction analyzed archival data from uncontrolled groups (Wales, 1979).

This report concludes that GD, as part of a larger revised freshman engineering program, helped increase graduates from West Virginia University's engineering program by almost a third, while the rate of graduation from other engineering programs remained constant during the same time period. Also, the average grade point of students completiing the entire program incorporating the GD classes was .19 of a grade point higher than that of transfer students not benefitting from the revised program.

The revised freshman engineering program consisted of several changes, "faculty concern and the introduction of a new competentcy based freshman program focused on teaching the skills of both single-answer problem solving and decision making" (Wales & Stager, 1977, p.85). The fact that the GD courses constituted six of 136 credit hours for the engineering majors (Wales & Stager, 1977,) makes a conclusive statement regarding the efficacy of GD very difficult. However, the conclusion made by Wales and Stager (1977, p. 88), "...since the introduction of the freshman program, fewer students drop out, and those who stay earn better grades during their years in college" indicates that GD courses can be a viable part of a larger program. Certainly, more research is needed on GD specifically, before any conclusions can be made regarding its effectiveness as an instructional method.

Personalized System of Instruction

The effectiveness of PSI as compared to conventional group instruction has been documented in hundreds upon hundreds of studies, resulting in one inevitable conclusion; PSI is at least as effective, but far more often superior, to the traditional lecture method of instruction (Kulik,

1976; Kulik, Kulik, & Cohen, 1979; Taveggia, 1976). For measures of end-of-course-performance, retention, transfer, facilitation and ratings, PSI has been established as a better teaching method (e.g., Kulik, 1982, pp. 5-7). The literature so extensively and consistently bares this fact out, that PSI's proven superiority over the traditional lecture method of instruction has now become, as Semb (1982, p. 56) stated: "a generally accepted conclusion".

Individualized Lecture Classes

Few efforts have been made to document the effectiveness of individualized lecture courses. Rather, the investigations of these classes have involved validating various individualizing components such as remediation (e.g., Bostow & Blumenfeld, 1972; Bostow & O'Conner, 1973) or proctoring (Phillips & Semb, 1977). And while these studies support the usefullness of individualizing components in individualized lecture classes, they offer little data for comparison of individualized lecture classes with traditional lecture classes.

One study (Phillips & Semb, 1976), compared academic performance in two sections that were systematically and repeatedly switched from pre-lecture to post-lecture quizzing. Thus, the role of the lecture was assessed. The students' resulting academic performances cast doubt on the importance of the lecture component, as they performed equally as well with or without the lecture. Another interesting finding of this study is that no significant difference was found between the pre or post lecture students' test performances and the performance of a PSI control group. The authors attribute this fact to a common remediation component; the individualizing component that has received the most attention

in individualized lecture class literature.

Another investigation (Spencer, Conyers, Sanches-Sosa, & Semb, 1974) reports exam scores of an individualized lecture course as being 7% lower compared to two PSI courses. In this study, the lecture class did not have a remediation component. Both the PSI courses and the individualized lecture class produced superior student performance than a control group class.

The question of what difference, if any, exists between individualized lecture courses and PSI was specifically addressed in a study by Semb (1980). In this investigation, some students were given a choice, and others were randomly assigned, to either a PSI group or an individualized lecture class. The results indicated that, regardless of the group, PSI students performed significantly better on exams, and rated the course higher; although both types of classes were rated favorably.

Hence, the role of the lecture in this highly programmed introductory child development course does not seem to be as valuable as other, more individualizing, components such as remediation (e.g., Sundberg, Malott, Ober, & Wysocki, 1978), self-pacing (e.g., Semb, Conyers, Spencer, & Sanches-Sosa, 1975), or unit size (e.g., Born, 1975). But the individualized lecture class does seem to be a viable alternative to the traditional lecture class. Much more research is needed to determine just what function lectures serve in higher level courses and courses that are not as highly programmed.

> The kind of change needed in education today is not one that will be evaluated in terms of the percentage of A's in a grade distribution, it is one that will produce a reinforcing state of affairs for everyone involved...
>
> Keller, 1968 p. 86

Grading

Evaluation of student performance has probably been around as long as educational institutions themselves (Kirshenbaum, Napier, and Simon, 1971). It most often takes the form of a grade. Grading can serve many purposes. For example, grades might be a consequence for students' performance, serving to increase or decrease the likelihood of similar performance again. Or, grades might be a standard by which students' performances are compared. And as Keller (Note 5) points out in this quote from St. Matthew: "...he shall separate them one from another, as a shepherd dividith his sheep from his goats.", grades are often used to cull.

Individualized instruction typically implies that students are encouraged to reach their maximum potential. The following section analyzes how each of the methods of individualized instruction reviewed in this paper handle the issue of evaluating student performance.

Audio-Tutorial

The A-T method of instruction proposed by Postlethwait et al., (1972) uses an objective percent-of-points-possible method whereby stu-

dents earn a grade corresponding to the cumulative number of points they have earned. The standard 90% - 100% = A, 80% - 89% = B, etc. method is used. In their words, "The A-T system is not a method for alleviating the strain on university facilities by eliminating students or a screening mechanism for students who are clever at 'beating the system'." (Postlethwait et al., 1972 p. 87).

In their class, the 14 ten-point oral quizzes, 14 20-point written quizzes, and 200-point comprehensive final exam constitute the points to be earned. Additionally, 28 bonus points can be earned by reporting on extra-reading assignments and two research projects must be completed for the grade of A, or one such project for a B, C, or D.

Guided Design

The GD system proposed by Wales and Stager (1977, p. 33) weights various student assignments to calculate grades: Attendance and participation = 15%, homework and quizzes on study guide objectives = 20%, and the assigned parallel project = 65% of the students' grade. The nature of the team projects requires all students to participate and hence, constitutes a portion of their grades. The quizzes serve the function of maintaining students' progress with the assigned readings. As Wales and Stager note (1972, p. 540), "...exams are used not to establish a grade, but simply to give the student feedback." Thus, students attending regularly and keeping current with the readings are better able to participate in their group as well as on their own parallel project.

Personalized System of Instruction

Students' grades, according to the original Keller (1968) plan, were a function of the number of lessons passed, a final examination, and laboratory assignments. In Keller's own classes, the unit quizzes constituted 50% of the students' grade, with 20% coming from ten laboratory exercises and 30% from the final.

The final was comprehensive, taking most of the questions from the unit quizzes. Students passing all the lessons, completing all the laboratory assignments, and passing the final with a 90% or better earned an A. Fewer lessons passed, fewer laboratory assignments completed, and a lesser score on the final comprised the rest of the grade distribution.

An alternative to this grading procedure is suggested by J. G. Sherman (Keller & Sherman, 1982 p. 32) where he suggests: "...retain only the A grade, the number of units completed determining how many credits of A have been earned." Hence, the student completing 80% of the coursework might only receive 2 of 3 possible credits for the class.

These descriptions are proposed by Keller and Sherman in an effort to adapt the PSI model to an academic setting. The ideal PSI grading policy according to Sherman (Keller & Sherman, 1982 p. 31), ". .suggests a simple statement of the requirements for an A (passing all units, passing the final exam) with an alternative of an Incomplete."

Individualized lecture classes

Because there is no one model, grading procedures differ among various classes using individualized lectures. Consequently, each class is as unique as the instructor teaching it. But these courses do have

many similarities, such as frequent quizzing, midterms, and final exams.

Drake, Phillips, and Semb (Note 3) describe their grading procedures thoroughly, which are probably representative of the basic format used in similar courses. In their child development class they have nine 20-point unit quizzes, two 102-point review exams, and one 90-point final. The unit quizzes constitute 37% of a students grade; the review exams, 44%; and the final, 19%. Grades are assigned according to the standard 90% - 100% = A, 80% - 89% = B,... method.

> As a means of imparting information, especially if habitually used, the formal lecture is probably the most ineffective and wasteful of all methods.
>
> (Schueler, 1951)

> When one is asked whether lecture is better... the appropriate counter would seem to be, "For what goals?"
>
> (McKeachie, 1963, p. 1126)

Lectures

The spoken word is most certainly the oldest means of conveying information. But since Gutenberg's printing press, and Edison's movie projector, new and exciting possibilities have set the occasion for a revolution in traditional education. Each of the four methods of instruction reviewed in this paper makes use of lectures, but in very different ways.

Audio-Tutorial

The A-T method of instruction is probably most famous for using the communication vehicle appropriate to the objective. With films, displays, books, recordings, and lectures at the students' disposal, it is easy to see why. The general assembly session allows the presentation of material best suited for large audiences. Guest lectures, long films, and major exams are all conducted in here.

The guest lectures, Postlethwait et al., (1972) hypothesize, might serve a motivational function, or they might not. Nevertheless, the A-T system uses group lectures in the GAS as a supplemental feature, but very rarely as the primary means of information transmission (Postlethwait et al., 1972 p. 18).

Guided Design

Wales and Stager (1976 p. 30), explain the role of lectures with their system quite well:

> ...without lectures to guide [illegible], students may have great difficulty handling text material. However, many teachers have already demonstrated that students can learn by self-study if they are supported by carefully selected text-books, by objectives, notes, or a study guide, or by the Personalized System of Instruction, programmed instruction, or Audio-Tutorial instruction.

In fact, PSI has already been sucessfully used in a GD course (Note 8). The authors go on to describe their own freshman engineering course at West Virginia University where each group's "project leader" is instructed to discuss homework assignments until all members of the group understand the instructional objectives.

Hence, lectures might be used in a G-D system, but they may not be an essential part of the students' educational experience. Further, the primary instructional vehicle in a GD course is the design project. This is written by the instructor and a list of "Do's and Don'ts" are provided for the course developer (Wales & Stager, 1976 p. 23).

Personalized System of Instruction

In contrast to individualized lecture classes, PSI uses lectures only in an ancillary role. Keller (1968) and Keller and Sherman (1982) suggest lectures be used, not as a means of information transmission, but to reinforce good student performance. In their words, (Keller & Sherman, 1982) "...PSI lectures are 'extras' and not required. They are usually poorly attended unless very, very good."

This latter statement has convincing experimental evidence behind it. The research to date indicates that lectures for which no quiz questions will be asked are poorly attended (e.g. Edwards, 1977; Hursh, 1976). That the use of lectures in PSI does not meet original expectations (Keller, 1968) is not to be of concern. Certainly other reinforcers can be used to encourage good student performance and attendance in PSI classes.

Individualized lecture classes

Because individualized lecture systems are lecture-based, the entire course organization must be scheduled accordingly. These courses divide the material to be covered into small units typically corresponding to chapters in the textbook used for the course. Students contact the course material by studying their book and objectives and attending lectures. After taking an initial quiz over a unit students needing remediation attend a remediational lecture. Difficult material and misconceptions are clarified using procedures described earlier in this paper.

Thus, the role of the lecture is central in this system of instruction making it the exception among the systems reviewed.

> A society which places such great value on education that it requires the individual to attend school for long periods of time must find the means to make education attractive and meaningful to the individual learner. Modern societies no longer can content themselves with the selection of talent; they must find the means for developing talent.
>
> (Bloom, 1976, p. 17)

Mastery

The four methods of instruction reviewed in this paper were all developed about the same time as Bloom's Mastery Learning theory (Bloom, 1968). Consequently, the philosophy put forth by mastery learning could have influenced the developers of A-T, GD, PSI, & individualized lecture classes.

Mastery learning theory states that it is not the equality of opportunity that is the goal of education, rather, it is the equality of learning outcomes (Block & Anderson, 1975). As will be seen, individualizing a course does not necessitate mastery from students, but mastery performance can be achieved without requiring it.

Audio-Tutorial

The A-T system as described by Postlethwait et al., (1972) does not require mastery by students. As they describe it (Postlethwait, et. al. 1972 p. 87):

> The grading system is based upon the approach that all students achieving a specific level of accomplishment shall receive a commensurate grade.

Hence, students are not required to master material. But the A-T system has been shown to be compatible with a mastery requirement as was demonstrated by Holland & Brown (1980). In this study 151 students from two schools enrolled in American history courses. One group was exposed to a lecture based instructor-paced course, while the other group was taught using a self-paced A-T method. In both groups, completion of stated objectives was based on mastery. The subsequent comparison indicated that the A-T system was quite amenable to a mastery requirement.

Guided Design

The problem-solving orientation of GD does not try to teach the answer to a problem. Rather, students arrive at a conclusion by following the steps involved in the system. Hence, mastery in a GD class is not a matter of students reciting the correct solution to a problem, rather it is the completioin of all the problem solving steps being taught.

Students must complete particular steps in order to proceed from one to the next, not because the instructor requires them to do so by course rule or grade contingency, but because the GD procedure requires them to do so in order to successfully complete the project. A group is not allowed to move on until all the students in that group have participated in each step (Wales & Stager, 1976 p. 55 and 65). In other words, students, in a group situation, need to complete specific material not because they are told to, but because the instructor designed the

project in such a way that it is imperative (Wales & Stager, 1976 p. 77).

Personalized System of Instruction

As Hursh (1976 p. 97), has stated:

> One of the features of (PSI) is the requirement that students master a unit of course material before progressing to the next unit.

Keller, (1968) described mastery as,

> the unit-perfection requirement for advance, which lets the student go ahead to new material only after demonstrating mastery of that which preceded.

Hence, the mastery requirment is an integral part of PSI.

Just what level of mastery should be required is a question that has not gone without experimentation. While the typical mastery requirement is set between 80% - 100% (Hursh, 1976), different mastery requirements can predictably alter student performance.

For example, Johnston & O'Neill (1973) systematically varied the mastery criterion in their psychology course. The results showed a strong adherence of student performance to the mastery criterion, whether raised or lowered. Similarly, Semb (1974) demonstrated that students performed better under a 100% rather than 60% criterion.

Individualized lecture classes

A mastery requirement is virtually impossible in an individualized lecture course because there is a limited number of retakes available. When each unit is based on a weekly lecture a student necessarily has a

fixed amount of time to remediate before the next lesson is due. Nevertheless, some remediation is possible and students are typically provided at least one attempt to improve their grades (see p. 19).

There is a growing body of literature, however, indicating that mastery level performance can be achieved not by requiring it before a student is allowed to procede, but by simply equating the grade of A with a mastery criterion (i.e., 90% or better). While students still do not have unlimited opportunities to retake quizzes or exams, a few studies have suggested the grade of A will serve to control student performance (Carlson & Minke, 1975; Johnston & O'Niell, 1973; Sundberg, Malott, Ober & Wysocki, 1978; Sussman & Valente, 1980).

So, while students who are denied the opportunity of unlimited retakes will not always be able to master instructional material, a very close approximation might be accomplished by adjusting the grading contingency used (i.e., the requirement for the grade of A).

> ...it has become evidient that a large portion of slower learners may learn as well as faster learners. When the slower learners do succeed in attaining the same criterion of achievement as the fast learners, they appear to be able to learn equally complex and abstract ideas, they can apply these ideas to new problems and they can retain the ideas equally well - in spite of the fact that they learned with more time and help than was given others.
>
> (Bloom, 1976 p. ix)

Pacing

Providing for differences between learners is one distinctive feature of individualized instruction. Two learning variables students can obviously differ on are rate and amount. Some students learn faster than others, and some more than others. However, the difference in amount of information learned can be greatly diminished by the use of a mastery requirement, or, as previously discussed, arranging contingencies such that students master material to earn an A. This would leave students differing, greatly, on only the rate of learning.

Many testing procedures take advantage of this difference in learners in an effort to distinguish individuals (e.g., college admissions tests). The underlying assumption is that fast learners are somehow superior to slow learners. In fact, "slow" is a common euphemism for students who do not perform as well as the mainstream.

Unfortunately, for the student, and society as a whole, the burden of improving a "slow" learner is typically placed on the shoulders of that learner. If students fail to learn enough over the course of the academic year, they are "held back" to perform better the second time around -- in the same environment which was unable to produce the desired educational improvement the first time. Only in the rarest of cases do parents, administrators, or teachers ask themselves, "How can the learning environment be changed to best fit the needs of this learner?" Individualized instruction systems respect the differential rates of learners, but, as will be seen, in different ways.

Audio-Tutorial

The A-T system makes use of the adage "success begets success" (Postlethwait, et al., 1972, p. 4) by clearly specifying what is to be learned, breaking the material into small units, and allowing students the number of repetitions they require to learn the material. This presumably results in reinforcement for prior contact with the material, which in turn, increases the likelihood students will continue to study. In Postlethwait's (1974, p. 201) words: "The audio-tutorial system allows students to proceed at their own pace and to break the subject matter into small units commensurate with their ability."

The pacing referred to here does not mean students can complete the course as quickly as they desire. The type of pacing A-T affords students regards the actual time spent in contact with the instructional materials in the A-T study booth. Students can take as long as they need to fully understand the day's lesson. Difficult portions can be repeated as often as necessary. The result of this feature is a student

who can meet the weekly objectives. The weekly objectives, however, are instructor-paced to accomodate the semester.

Guided Design

Guided Design is just that, guided. Students are taken through a series of small problems ultimately ending with a solution to some larger problem. The instructor guides the students through the use of written materials acted on by the small groups of students. Pacing, therefore, is necessarily dictated by the day's lesson selected by the instructor.

However, students solving a problem work together, cooperatively, waiting to move on until every member of the group verbalizes an understanding of the material. Thus, the group is self-paced to the extent that they are not bound to the other groups in the class. Also, the instructor has a check on the group's progress as they must receive the Feedback-Instruction materials to go on. This provides an opportunity for the instructor to interact with the groups, making sure their performance is satisfactory, and subsequently reinforcing their efforts.

Pacing for classwork or homework done outside of the "problem solving" exercise is discussed by Wales and Stager (1976 p. 70). They suggest:

> If you decide to try Guided Design in your class, we suggest you schedule and pace not only the students' study and homework, but their quizzes and examinations as well.

The rationale for this statement is the fact that many students have yet to learn how to best manage their time. Consequently, students might

not keep up with readings and outside assignments designed to prepare them for the problem-solving exercise (Wales, 1976 p. 391; Wales & Stager, 1977 p. 70).

Personalized System of Instruction

> In the Personalized System of Instruction the diversity in patterns of student progress is accommodated by allowing students to pace themselves through discrete units of content. (Hursh, 1978 p. 32).

PSI, as orginally designed, allows students to move as rapidly or slowly as they desired (Keller, 1968). While this feature is a welcome luxury to students who are new to PSI courses, it can also be problematic for students needing to master a fixed amount of material in a set period of time. The next sentence following the previous quote from Hursh is:

> As with most behavior that is controlled by a fixed deadline, this 'self-pacing' feature of most PSI courses often results in procrastination on the part of the students.

In the PSI Handbook, Keller and Sherman (1982 p. 39) offer the following suggestion to potential adopters:

> A special warning. Students in a PSI course have great control over their own activities. It is probably wise to advise them that this responsibility has a danger. You may wish to invite those who have not developed good study habits and the needed self-control to consult with you as to how to manage the freedom the system provides. A few students may wish to set up a contract system until they learn how to manage their own behavior. No student plans to fail; a few

students fail to plan and need a little help to learn the skills of self-control.

That PSI causes or contributes to student procrastination has been effectively argued (Born & Moore, 1978). Their analysis suggests many students in all forms of instruction procrastinate but go unnoticed because of infrequent samples of student study behavior. Students who are monitored daily on their progress through many units are much more likely to be "caught" procrastinating.

Nonetheless, the procrastination issue has received a great deal of attention in the literature. A study examining no contingency, loss of points for procrastinating, points only for work completed on time, and bonus points for work completed ahead of schedule was conducted by Semb, Conyers, Spencer, and Sanches Sosa (1975). Ninety percent or more of the students completed the course on time in the latter three groups, compared with only about three-fourths of the students in the no contingency group. Therefore, it would seem particularly important to attend to students self-pacing in courses that also require mastery in a fixed amount of time.

Individualized lecture classes

Individualizing lecture courses necessitates instructor pacing if the students are presented with one unit per week with the corresponding lecture, quiz, and remediation quiz. Students are not allowed to lag behind or progress ahead of the course schedule. Typically, units missed or failed become history.

However, in a study previously cited in this paper (Sussman et al., 1980), some clever innovations were successfully employed in a lecture

based course. In this study the first class hour of each week was devoted to that week's unit lecture, with the following hour scheduled for a group discussion period. Students were allowed to move ahead to the next unit provided they attempted the prior unit. In their words:

> One attempt on Unit n was required before advancing to Unit n+1. Students could not, in any one testing session, attempt a particular unit more than once, and/or more than a total of two units. Beyond these limitations, there were no further restrictions on how the remaining sequence of retesting, if any, was accomplished.

Thus, students could not only progress faster than the course schedule, but also go back and retake previous lessons in an effort to improve their cumulative score. The combined effect of no mastery requirement and a self-paced schedule resulted in what might be the only article in the Journal of Personalized Instruction with the words, "there was no evidence of procrastination" written in the results section (Sussman et al., 1980 p. 76).

> Learning takes place throughout the world in the absence of an acceptable theory.
>
> (Bloom, 1976 p. 1)

Theoretical base

B. F. Skinner (1959) has effectively argued against research for the purpose of theory building. A collection of facts, he proposes, may be formally represented by a theory, but this representation should not interfere with research. Rather, theory should be derived from research. Nonetheless, theories exist and are used ubiquitiously to construct instructional systems (e.g., Craig, 1983 pp. 30-53). The four instructional systems reviewed in this paper all claim some form of theoretical base. As will be seen, however, the types of theories and the attachment to them varies considerably.

Audio-Tutorial

A-T is strictly cognitively oriented. Postlethwait et al., (1972 p. 125) cite David Ausubel (1968) as a model of the theory they subscribe to. In their words:

> We all recognize that children must want to learn if we are to succeed in teaching. Motivation for learning, we say, is necessary. Aversive methods of motivation do work, but unfortunately learning tends to stop when the aversive pressures cease. We can employ ego-enhancing motivation (praise, group

> recognition, 'gold stars,' status advancement), but this kind of motivation works only when some students are denied it, or are subject to aversive motivation. The most common practice is to combine aversive and ego-enhancing motivation to achieve some level of student commitment to learning.

According to Postlethwait et al., (1972) the goal of A-T is to instill knowledge in learners in a manner that associates the new information with previously learned concepts. The assumption being that this learning will be more meaningful than mere rote learning.

Ausubel's (1968) model states students must possess subsumers, or relevant concepts already in the cognitive structure, to learn meaningfully. Subsuming concepts, according to this model, facilitate the assimilation of new information whereby "both the rate and the quality of learning are affected" (Postlethwait et al., 1972 p. 126).

If subsumers do, in fact, facilitate the acquisition of new material by pairing them with previously learned relevant concepts, how can students who have had little or no previous exposure, and consequently few relevant concepts, learn new material? Novel material, the theory states, must be rotely learned. But this rote learning can be aided by advanced organizers that teach basics to be used as a foundation for subsuming concepts to be formed (Ausubel, 1968).

Guided Design

As was stated earlier (p. 12), GD is eclectic, drawing its theoretical base from several psychological camps. Behaviorism, cognitivism, and humanism are all represented. In the words of Wales and Stager (1977 p. 58):

If B. F. Skinner is correct we are all products of the reinforcement we have received. If Abraham Maslow is correct only about 5% of our population have been so well reinforced for dealing with change that they now operate as independent, adaptive, creative, self-actualized, decision-makers. Those who value these qualities should find the concept of Guided Design appealing.

Many of the characteristics of Guided Design are highly recommended by some psychologists. One example would be Carl Rogers (1968), who in his book Freedom to Learn described education in these terms:

1. Human beings have a natural potentiality for learning. They are curious about their world, until and unless this curiosity is blunted by their experience in our educational system.
2. Significant learning takes place when the subject matter is perceived by the student as having relevance for his own purposes.
3. Learning which involves a change in self organization - in the perception of oneself - is threatening and tends to be resisted.
4. Those learnings which are threatening to the self are more easily perceived and assimilated when external threats are at a minimum.
5. When threat to the self is low, experience can be perceived in differentiated fashion and learning can proceed.

6. Much significant learning is acquired through doing.

7. Learning is facilitated when students participate responsibly in the learning process. When they choose their own directions, help to discover their own learning resources, formulate their own problems, decide their own course of action, live with the consequences of each of these choices, then significant learning is maximized.

8. Self-initiated learning which involves the whole person of the learner - feelings as well as intellect - is the most lasting and pervasive.

9. Independence, creativity, and self-reliance are all facilitated when self-criticism and self-evaluation are basic and evaluation by others is of secondary importance.

10. The most socially useful learning in the modern world is the learning of the process of learning, a continuing openness to experience and incorporation of oneself of the process of change."

The psychological basis for GD according to Wales and Stager (1977 p. 61) includes modeling, practice, advance organizers, competency-based testing reinforcement, and more, in an environment that satisfies Maslow's (1968) need hierarchy.

Hence, GD attempts to teach by creating a learning environment that allows a person to perform at their best -- self-actualized -- and motivates through reinforcement with help from modeling to prompt the desired behavior.

Personalized System of Instruction

Of the four methods of instruction reviewed in this Paper, PSI has the strongest attachment to a theoretical base. The reason - PSI's "father," Dr. Fred S. Keller. Dr. Keller entered the department of psychology at Harvard University in the late 1920's (Note 9). There he developed a life-long friendship with the scientist that the American Psychological Association voted as the most influential psychologist of our time - B. F. Skinner. Needless to say, Dr. Skinner and Dr. Keller have both proven their committment to the science of human behavior - radical behaviorism (cf, Skinner, 1979).

Dr. Gilmour Sherman, the predominant contributing colleague to the development of PSI, shares this commitment to behaviorism and its application to education (Note 10). In his words (Sherman, Ruskin, Semb, 1982):

> Unlike some educational innovations, PSI is rooted in a system: learning-reinforcement theory. The basic law of that theory, Thorndike's law of effect states, 'responses followed by reinforcement increase in frequency.' The law dictates one critical function, essential for effective instruction, the response-reinforcement contingency. That is, there is a relationship between behavior and its consequences. Instruction which casts the student in a spectator role, the receiver of a presentation, or leaves the results of active participation to chance, ignores the law of effect, neglects the functional relation it specifies, and breaks the most fundamental law of learning. The traditional lecture system is an example

- too often it is not working. (p. vii)

Hence, PSI is a product of behavioral psychology with an emphasis on the three term contingency:

S----> R----> C

Where S = stimulus, R = response, and C = consequence.

Driving home the point while adding an emphasis on individualized instruction, Sherman (1982) has stated:

> Teaching individually is a significant step forward only when the contingencies responsible for learning are adjusted in a way that is sensitive and responsive to each person. Personalized instruction has put us in a new position to analyze the consquences which control learning, and insure that the appropriate contingencies exist in the classroom, or where ever else a PSI course exists. (p. 327)

Keller's six assertions listed on page 21 of this paper all stem from constructing an instructional methodology based on reinforcement theory (Keller, 1982). In his words:

> Reinforcement theory, as the reader may have noted, was very influencial in my thinking from the time that I began to understand it, back in 1938. Soon after that I tried to carry out experiments that would extend the system, and I undertook to tell my pupils about it. ... My intellectual life, if I can call it that, began when I read the book that first described this system - Skinner's The Behavior of Organisms, a book that is today a classic in the science of behavior. (p. 32)

Behavioral psychology, behavior analysis, the experimental analysis of behavior, or whatever one chooses to call the science of human behavior, has specific principles that are used to the advantage of the learner in PSI. For example, as has been mentioned, people learn by doing. The consequences of their behavior will increase or decrease their behavior. Similarly, various aspects of education can be manipulated in such a way as to best make use of this fact. Immediate feedback on performance and the opportunity to retake tests without penalty (Keller, 1982 p. 50) are clearly a result of applying the principle of reinforcement theory.

The proctor, a distinct feature of PSI, is in Keller's (1982) opinion the most reinforcing component of the PSI package. In describing the reinforcing attributes of proctors he has written;

> The proctor is the greatest agent of reward. He or she is the source of several generalized reinforcers - attention, approval, and even affection, as well as the token reward of A that is given with the passing of every unit test. A proctor never punishes the student for anything and often cues the student (provides the discriminative stimulus) to behave in a manner that will guarantee some academic gain. He or she may help extinguish the anxiety or fear which the testing-grading situation arouses in the student. Finally, the proctor is the one who provides the early feedback from the student's test performance and permits defense of the answers. No wonder students say, "the proctors are the greatest!" (p. 50)

Compare Keller's quote with this from Skinner (Note 11) in a discussion of punishment in education;

> Education has a long punitive history. The cane and the taws (a leather strap, which, like the policeman's truncheon, leaves fewer permanent marks) are still used in British schools, and the paddle is once again in use in America. Even without corporal punishment, teachers are still so punitive that most students simply study to avoid the consequences of not studying. (pp. 8-9)

PSI is firmly rooted in a behavioral paradigm.

Individualized lecture classes

As was mentioned earlier, the individualization of lecture classes originated at Western Michigan University under the creative guidance of Dr. Jack Michael. Dr. Michael, a past president of the Association for Behavior Analysis, is a renown psychologist whose theoretical alleagance is unwavering (e.g., Michael, 1980). Dr. Michael's system for individualized lecture classes is based on the principles of behavioral psychology. Behavioral research methodology abounds in the the literature of individualized lecture classes (e.g., Barkmeier, Duncan, & Johnston, 1978; Bostow & O'Conner, 1973; Semb, 1974).

Systems that incorporate adaptable components of PSI without completely using the PSI methodology are called SLI - something like it (Keller, 1982; Kulik, Jaska, & Kulik, 1978). Because individualized lecture systems are derived from the PSI model, the best analysis of their theoretical base would be performed by analyzing PSI. The overlap between the two methodologies is considerable.

Little steps for little feet.

J. Brackmann (Note 12)

Unit size

In traditional group instruction, students are typically evaluated twice, once in the middle of the term, and then again at the end of the term (the final). Hence, students have only two opportunities to assess their progress in a course. The final comes too late to change any study habits, and the midterm really offers only enough information to decide whether or not to continue in the course.

But what of the four methods reviewed in this paper? How do A-T, GD, PSI, and individualized lecture classes treat units of information? As will be seen, they are all sensitive to students' needs, but each methodology is different.

Audio-Tutorial

Elwood (1970) has warned against simply recording a lecture and calling it an A-T system. In his words: "The hope that a given arrangement of hardware is going to produce ipso facto better teaching-learning situations is, alas, a false hope." Indeed, the designers of the A-T system recognize the importance of carefully planned units. Postlethwait et al., (1972 p. 3) list some of the ingredients of an educational program. An emphasis is placed on making units small but flexible, adaptable to each student's individual needs.

Besides presenting basic material - upon which later material will add - first, A-T makes use of multiple study activities sequenced and related in such a way as to help students associate the material more easily. To date, however, no systematic investigations manipulating various unit structures in a A-T format have been conducted.

Guided Design

Because GD is a problem-solving approach, units consist of steps in the decision-making process. The decision-making process is quite amenable to being broken-up into discrete steps, each building upon the prior. Wales and Stager (1972 p. 459) and Wales (1976 p. 391) have described how these instruction-feedback steps organize material in an efficient manner that allows students to progress from simple to more complex tasks. These steps (see pp. 14-16 in this paper) insure the gradual and successful solution to a problem.

Thus, units in a GD course are defined by the decision-making steps which are carefully sequenced by the instructor to provide for the most thorough analysis of the problem being solved. As with A-T, no systematic manipulation of the decision-making steps has been published. However, the sequence has received revision (cf. GDN, 1983).

Personalized System of Instruction

In contrast to A-T, GD, and individualized lecture classes, PSI has generated considerable research investigating the effects of various unit lengths (e.g., Born, 1975; Nelson & Bennett, 1973; O'Neill, Johnston, & Walters, 1975; Semb, 1974). Taken together, these studies support the use of small units as advocated by Keller (1982 p. 35) and

Keller and Sherman (1982 p. 25). However, the results of these investigations are mixed. While Born (1975) found little difference between students required to study one, two, or three units of material per quiz, Semb (1974) found that students improved 10-20 percent over pretest measures when exposed to short, compared to long, units.

Nonetheless, Keller and Sherman (1982) provide the following advice for constructing unit assignments:

> There is no formula. The nature of the material in a few disciplines may dictate unit size and test length. A unit usually covers about a week of work. An average unit size can be arrived at indirectly. Unit tests should normally require fifteen to twenty minutes to answer and about five minutes to correct. Longer tests tend to be avoided, encouraging procrastination. Tests that take more time to correct and discuss produce waiting lines unless there is a large number of proctors. The tests are designed to quiz the student on every major unit objective and should not merely sample and thus estimate what has been learned. This limits the unit size to an informational content that can be fully tested in fifteen to twenty minutes. Units are too long when one must resort to sampling, or dramatically extending the test time in order to be comprehensive. Although this rule-of-thumb is indirect and approximate, it is better than a decision rule based on some fixed number of pages, or alternatively, taking chapters as they are in most textbooks and making a unit equal a chapter. (p. 25)

Individualized lecture classes

One of the features of individualized lecture classes is that of unit assignments. Because the instructor paces the course (Drake et al., Note 3), the student has no control over what material will be covered. Typically, the instructor tests one "unit" a week. But what constitutes a unit is idiosyncratic to each instructor.

Most units in an individualized lecture class correspond to an assigned reading of a textbook chapter. Three or four units passed constitute a large enough sample of the course content to warrant a review over the material learned up to that point. Hence, review number 1 would likely cover lessons - or units - one through four, review II, one through eight, and so on. However, individualized lecture classes rarely fit this model exactly (cf., Drake et al., Note 3).

A comparative matrix

Method:	A-T	GD	PSI	Individualized lecture
General description :	A multi-media approach to individualized instruction typically used to teach biology.	An instructional method used in small groups to teach decision making.	A mastery based form of individualized instruction typically used to teach social sciences.	A derivative of PSI that retains the use of lectures.
Effectiveness	Probably better than conventional lecture. Needs more research.	Might be better than conventional lecture. Needs more research.	Definitely superior to conventional lecture.	Can be better than conventional lecture. Needs more research.
Grading:	Percent of points from unit quizzes and a comprehensive final.	Individual projects = 65% quizzes = 20% and participation = 15%.	Percent of points from unit quizzes and a comprehensive final.	Percent of points from unit quizzes and a comprehensive final.
Lecture:	Serves a supplemental role.	Can be used to transmit information.	Serves a motivational role only.	One primary means of information transmission.
Mastery:	Not required but influences grade.	Group mastery is required to progress to the next component.	Required to progress to the next unit.	Not required but influences grade.
Pacing:	Self-paced within the weekly unit.	Group paces itself during the class.	Students pace themselves during the term.	Self-paced within the weekly unit.
Theoretical base:	Strongly cognitive.	Very eclectic.	Strongly behavioral.	Typically behavioral.
Unit size:	Small flexible and adaptable units.	Carefully sequenced discrete steps. that build upon each other.	Small easy to master units - 1 per week.	Small easy to master units - 1 per week.

CONCLUSION

The fundamental trouble today is that...
the schools do not appear to work.
(Note 13)

Some similarities and differences between A-T, GD, PSI, and individualized lecture classes are apparent. Each system has inherent advantages and problems - depending on a consumer's needs. Educators trying to teach decision making might be interested in a Guided Design system because of its emphasis on teaching how to work through open-ended problems to arrive at a solution to those problems. Classes with subject matter that is difficult to explain in a written or verbal presentation would seemingly warrant an Audio-Tutorial system. However, both of these instructional systems need more research of higher quality than currently exists in the literature.

The literature does indicate that material, easily explained in writing, can be taught quite effectively using the Personalized System of Instruction. And for the courses, graduate level for example, that require in-class discussion the technology for individualizing lecture classes is a viable alternative to the traditional group-lecture system when individualizing components such as remediation or proctoring are incorporated.

The three specific instructional systems, A-T, GD, and PSI, share favorable and unfavorable aspects of initial start-up and subsequent

maintenance. For example, educators converting to one of these systems will find that the development of materials, tests, etc., takes an inordinate amount of their time. Similarly, instructors might feel alienated from their own courses after setting them up to run without the need of lectures. Students, fellow faculty, and, most likely, the administration may object to a new system that allows the instructor to "escape" (Keller, 1982 p. 47) their lecturing responsibilities. "Grade-flation" will most certainly come up as a controversial point also (Sherman, 1976, p. 28).

On the other hand, many favorable effects of adopting an individualized instructional system can be experienced. For example, the degree to which students are involved with their own learning could be increased dramatically. This is probably one good reason why students rate these teaching systems favorably as compared to traditional methods of instruction (e.g., McMichael & Cory, 1969; Miller, 1981; Sparks & Unbehaun, 1971). Also, each system allows an instructor to evaluate and monitor students' progress much more effectively than a traditional teaching system. And certainly the fact that these systems are geared for student success, rather than screening, is an advantage to those educators interested in the philosophy of individualized instruction -- helping students learn.

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